Indian J. Fish., 62(3) : 21-27, 2015

Stock and population characteristics of the Indian rock lobster *Panulirus homarus homarus* (Linneaus, 1758) from Kanyakumari, Tamil Nadu, on the southern coast of India

R. THANGARAJA, E. V. RADHAKRISHNAN AND REKHADEVI CHAKRABORTHY
ICAR-Central Marine Fisheries Research Institute, P. B. No. 1603, Kochi - 682 018, Kerala, India
e-mail: rajastarson@rediffmail.com

ABSTRACT

Stock parameters of the Indian rock lobster, *Panulirus homarus homarus* were estimated from the commercial landing data (2007) collected from Kanyakumari District on the southern coast of penninsular India. The estimated annual average landing of lobsters (2000-2011) in Tamil Nadu was 233.5±77.05 t. *P. homarus homarus* formed 47% of the total average lobster landing in Tamil Nadu. The stock showed two annual cohorts which is evident from two spawning peaks. Mortality parameters Z, M, F and exploitation rate E were estimated as 2.51, 0.67, 1.84 and 0.73, respectively using length converted catch curve method. Probability of capture Lc_{50} was 46.75 mm CL with $L_c/L_\infty = 0.39$. The estimated E_{max} was 0.65. Growth parameters L_∞ and K were estimated as 119.4 mm CL and 0.30 respectively. The Y/R and B/R were estimated as 0.39 and 2.23. Recruitment pattern for *P. homarus homarus* showed two cohorts which was represented by two recruitment peaks. The study revealed that *P. homarus homarus* from Kanyakumari District is overexploited and the decline in catch over the years suggests adoption of responsible fishing methods to sustain this high value coastal resource.

Keywords: Growth parameters, *Panulirus homarus homarus*, Population characteristics, Stock assessment

Introduction

The Indian rock lobster *Panulirus homarus homarus* (Linneaus, 1758) is a high value coastal crustacean resource which is widely distributed along the south-west and south-east coasts of India. The species is exported live and as frozen tails from India. Spiny lobster fishery along the southern coast of India is supported by *P. homarus homarus*, *P. ornatus* and *P. versicolor* and of these *P. homarus homarus* is the dominant species (Radhakrishnan, 1995; Thangaraja, 2011). It is a shallow water species with wide distribution along the southern coast. On the south-east coast, this species has a distribution range from Chennai to Kanyakumari while on the south-west coast, the distribution is limited, from Kanyakumari to Malabar coast of Kerala. On the south-west region good quantities of this species are landed along Muttom, Khadiyapatanam, Colachel, Enayam, Vizhinjam and Kollam regions. The spiny lobster resource along southern India is under extreme fishing pressure due to unregulated fishing, resulting in drastic decline in commercial landing (Radhakrishnan *et al.*, 2005). These lobsters are mainly caught by bottom-set gill nets (BSGN), trammel nets, traditional traps and occasionally trawl nets. The species is also caught by skin divers in inshore rocky areas. The fishery and biology of *P. homarus homarus* in Kanyakumari District were studied by Miyamoto and Shariff (1961), Balasubramanyan *et al*. (1960, 1961), George (1965), Mohammed and George (1968) and Radhakrishnan *et al*. (2005). Vijayanand *et al.* (2007) enlisted the lobster landing centres of the Kanyakumari coast. However, information on the stock parameters and biological reference points for this high value lobster species is limited. The present study attempted estimation of population parameters and growth pattern of *P. homarus homarus* from Kanyakumari District in the southern coast of India.

Materials and methods

Monthly sampling of *P. homarus homarus* was carried out at Khadiyapatanam and Chinnamuttom lobster holding centers during 2007, where lobsters from other landing centers of Tamil Nadu coast are brought for live packing and export. Carapace length (CL) of *P. homarus homarus* samples from both centres were measured with a digital vernier caliper. Lobsters of both sexes (males, n = 225; females, n = 271) ranging from 22.2 mm to 114.5 mm CL were collected and used for stock assessment. Annual estimates of lobster landing of Tamil Nadu coast were obtained from the Fishery Resource Assessment Division of the ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI), Kochi.

Length frequency data were grouped into 2 mm CL groups. The monthly length frequency data of *P. homarus*

homarus was computed using the FiSAT-II software (v.1.2.2.). Age and growth parameters were estimated using von Bertalanffy growth function (VBGF); the asymptotic length (L_∞) and annual growth coefficient (K) were estimated using ELEFAN–I option in FiSAT-II software (Pauly, 1987). K-scan was carried out to obtain a reliable estimate of the K value following Pauly and David (1981). The von Bertalanffy growth function (Bertalanffy, 1960) $L_t = L_\infty(1-e^{-k-(t-t_0)})$ was fitted to estimate the length at age curve, where L_t= mean length at age t_0, L_∞= asymptotic length; t = age of *P. homarus homarus* and t_0= hypothetical age at which length is zero. The total mortality coefficient (Z), natural mortality rate (M), fishing mortality (F) and exploitation rates (E and E_{max}) were estimated by length converted catch curve method using ELEFAN I and the empirical relationship explained by Pauly (1980, 1983, 1984). The yield per recruit, Y/R and biomass per recruit, B/R were predicted by keeping the L_c (mean length at first capture) constant (Pauly and Soriano, 1986).

Results

The spiny lobster *P. homarus homarus* is mostly distributed along the shallow and submerged rocky region of south Indian coast (Fig. 1). The total annual landing of lobsters in Tamil Nadu ranged from 142 to 187 t during the period 2000 to 2011 with a maximum of 430 t in 2008, of which *P. homarus homarus* contributed 47% (Fig. 2). On the south-west coast, the major landing of the species was at Muttom, Khadiyapatanam, Colachel, Enayam, Vizhinjam and Kollam. On the south-east coast, major landings were reported from Chennai, Kovalam, Rameswaram, Tuticorin, Ovari, Arokiyapuram and Chinnamuttom fishing centers. Bottom-set gillnet (BSGN) is used for lobster fishing in most of the centers and in some areas traditional traps as well as trap designed

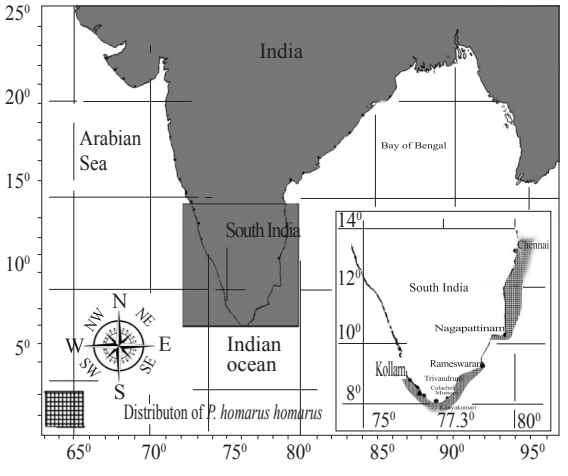

Fig. 1. Map showing distribution of *P. homarus homarus* in coastal waters of south India.

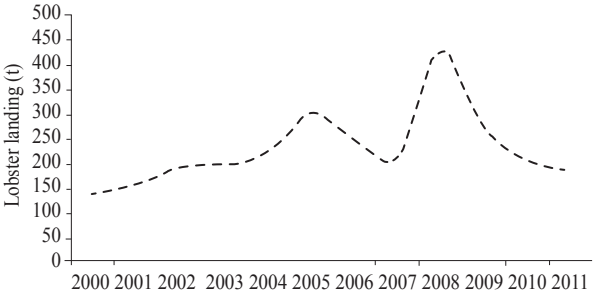

Fig. 2. Lobster landing in Tamil Nadu (2000- 2011)

by ICAR-Central Institute of Fisheires Technology ICAR-(CIFT) are also used. Although lobsters are consistently caught in small numbers almost throughout the year, the peak fishing season is from October-January in Khadiyapatanam and Chinnamuttom (Table 1).

Age and growth of P. homarus homarus

Growth parameters of *P. homarus homarus* were estimated as L_∞=119.4 mm CL and K = 0.30 per year. The fitted plot of ELEFAN graph is shown in Fig. 3.

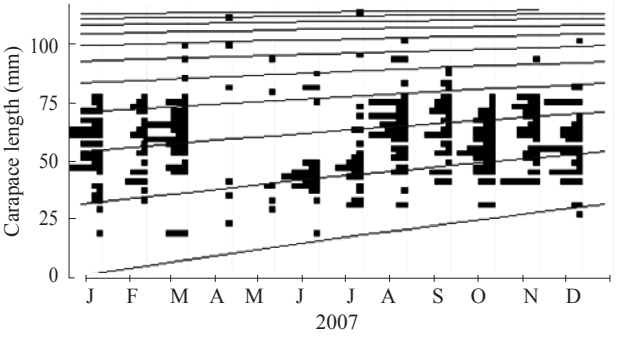

Fig. 3. Length frequency plot of *P. homarus homarus* fitted using ELEFAN I

Mortality estimate and exploitation rate

Mortality parameters such as total mortality (Z), natural mortality (M) and fishing mortality (F) were 2.51, 0.67 and 1.84, respectively. The M/K ratio of *P. homarus homarus* was found to be 2.23. The exploitation rate E is estimated as 0.73. The high exploitation rate shows that *P. homarus homarus* resource in coastal waters of south India is under high fishing pressure. The mortality estimates using length converted catch curve is shown in Fig. 4.

Length at capture

Probablity of capture Lc_{50} shows 46.75 mm CL with the L_c/L_∞= 0.39. The low Lc_{50} (Fig. 5) value shows that a major percentage of *P. homarus homarus* caught is undersized, considering the length at maturity of the species at 55-60 mm CL (Thangaraja, 2011).

Table 1. Fishing season for lobsters at major landing centers along the Kanyakumari coast

Villages/Lobster landing centers	Region	Types of gear	Lobster species	Fishing season
Kanyakumari	S	BSGN/TP/TR	*P. homarus homarus* *P. ornatus,* *P. versicolor** *P. longipes**	September-March
Chinnamuttom #	SE	BSGN/TR	*P. homarus* *homarus* *P. ornatus* *P. versicolor* *P. longipes**	September- January
Arokiyapuram	SE	BSGN/TP	*P. homarus homarus,* *P. ornatus* *P. versicolor*	October- February
Manakudy	SW	BSGN/TRMN	*P. homarus homarus*	September – February
Rajakkamangalam	SW	BSGN/TRMN	*P. homarus homarus*	September – February
Muttom	SW	BSGN/TP/SD	*P. homarus homarus* *P. ornatus**	September – February
Khadiyapatanam #	SW	BSGN/TP/SD	*P. homarus homarus* *P. ornatus** *P. versicolor**	September- March
Colachel	SW	BSGN/TP	*P. homarus homarus*	September- March
Enayam	SW	TP	*P. homarus homarus*	October- March

BSGN: Bottom-set gill net, TP: Trap, TR: Trawl, TRMN: Trammel net, SD: Skin diving, *: Negligible, **#:** Study Area, SW: south-west, SE: south-east, S: southern

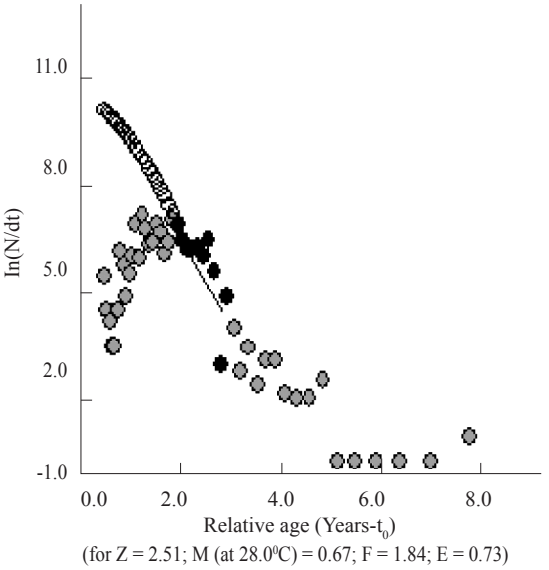

Fig. 4. Length converted catch curve of ELEFAN-I for *P. homarus homarus*

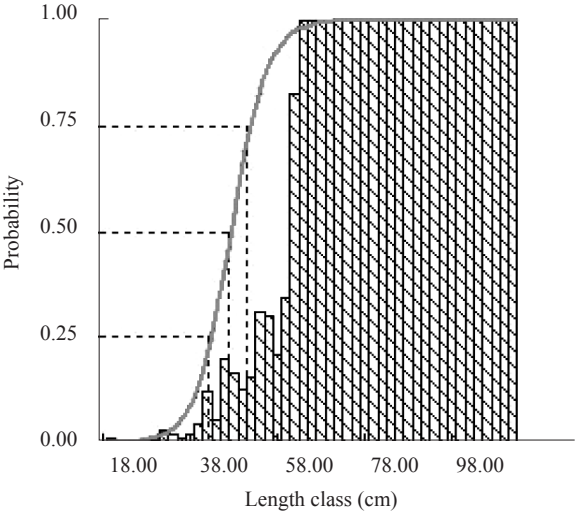

Fig. 5. Probability of capture plot of *P. homarus homarus* from ELEFAN I

Yield/recruit (Y/R) and biomass/recruit (B/R)

The Y/R and B/R were estimated by deriving L_c/L_∞ and M/K which was 0.39 and 2.23, respectively. Higher (Y/R)' was obtained at E_{max} = 0.65. As the exploitation rate increase beyond this value, relative yield per recruit reduced (Fig. 6). Higher exploitation rate E = 0.73 compared to E_{max} explains the higher mortality due to fishing, F=1.84.

Recruitment pattern

Recruitment pattern analysis for *P. homarus homarus* in the present study showed two cohorts annually (Fig. 7) which correlates with the continuous breeding activity of *P. homarus homarus*. Breeding activity has been reported from September-January with peak during November - December months (Thangaraja and Radhakrishnan, 2012).

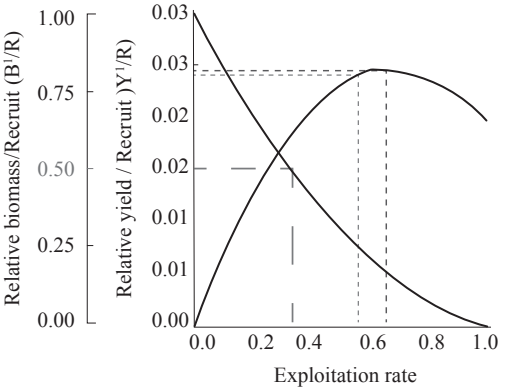

Fig. 6. Yield per recruit and biomass per recruit of *P. homarus homarus*

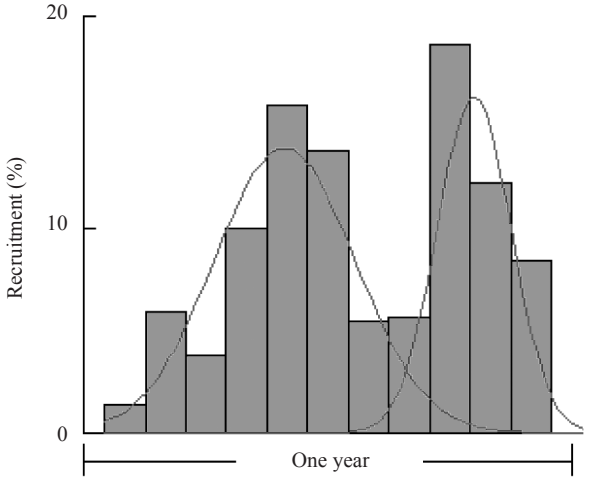

Fig. 7. Annual recruitment pattern of *P. homarus homarus*

Virtual population analysis (VPA)

Virtual population analysis shows the fishing mortality was maximum from size range of 45 mm CL to 80 mm CL (Fig. 8).

Discussion

Investigations on the biology and fishery of *P. homarus homarus* along the coastal waters of south India carried out in late 1950 and 1960's at Muttom (south of Khadiyapatanam) and Colachel (north of Khadiyapatanam) revealed that the major fishing season is during November-April with a peak in December (George, 1965). Fishery and biology of *P. homarus homarus* of Kanyakumari District were studied during the period 1950-1960 by Miyamoto and Shariff (1961), Balasubramanyan *et al*. (1960; 1961), George (1965), Mohammed and George (1968), Radhakrishnan *et al*. (2005) and Thangaraja (2011). During 1960s and early 1970s, Kanyakumari District in Tamil Nadu was the most productive lobster fishing region in the country.

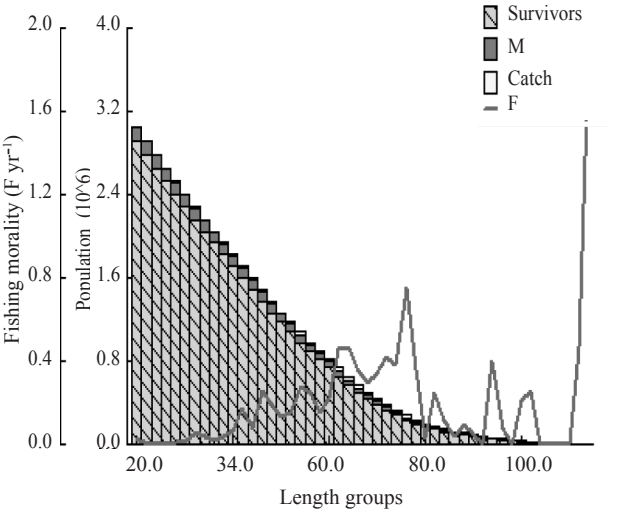

Fig. 8. Virtual population analysis (VPA) of *P. homarus homarus*

Intensive exploitation due to attractive prices offered by the exporters resulted in the decline of catches in this area and by 1978, Maharashtra and Gujarat became the leading lobster producing states in India (Radhakrishnan *et al*., 2005; 2007).

George (1965) reported lobster landing in numbers and on conversion to weight (assuming average weight of *P. homarus* caught as 300 g based on the modal length of 185 mm TL), the combined estimated landing of *P. homarus* at Muttom and Colachel during 1958-59 was 39 t. The landing, which declined to 14 t during 1959-61, increased to 32 t in 1961-62 with a further decline in 2006 (7.7 t) (Thangaraja, 2011). The present assessment of population parameters for *P. homarus homarus* stock in coastal waters of south India shows high exploitation rate (E=0.73) and high fishing mortality (1.84). The annual growth coefficient K (0.30) obtained in the present study is in close conformity with the K value obtained for the sub species *P. homarus megasculpta* from Oman, 0.33 (Al-Marzouqi *et al*., 2007) and 0.36 (Al-Abdusalaam, 1989) (Table 2). A higher K value of 0.72 yr^{-1} for the same species has also been estimated recently from Oman coastal waters with L_{∞} of 144.85 mm CL (Mehanna *et al*., 2012). The present estimate is also in close agreement with the K value estimates for *P. homarus homarus* from Sri Lanka and *P. homarus megasculpta* from the population in Yemen (Sanders and Bouhlel, 1984). The growth parameters of different subspecies of *P. homarus* estimated by various authors from different geographic locations are given in Table 1. Nair *et al*. (1995) conducted laboratory culture of *P. homarus* for studying the growth rate of the species. They found males ranged from 45 mm to 56 mm CL (122- 150 mm TL) and females from 33 to 57 mm CL attaining size ranges of 57-72 mm CL

Table 2. Growth parameters of different subspecies of *P. homarus* estimated by various authors at different geographic locations

Geographic location	Species	Authors and year	L_∞ (mm)	K	t_0	Sex
Oman	*P. homarus megasculpta*	Al-Abdusalaam (1989)	139.0CL	0.36	-	pooled
		Mehanna *et al.*(2012)	143.16	0.72	-	Pooled
Sri Lanka	*P. homarus homarus*	Jayawickrema (1991)	28.7 TL	0.43	0.38	pooled
Somalia	*P. homarus homarus*	Fielding and Mann (1999)	127.0 CL	0.46	-0.61	M
			110.0 CL	0.43	-0.53	F
Oman (Arabian Sea)	*P. homarus megasculpta*	Al-Marzouqi *et al*. (2007)	128.9 CL	0.33	-0.35	pooled
Yemen	*P. homarus megasculpta*	Sanders and Bouhlel (1984)	225.0TL	0.45	-	pooled
India (Southern Indian coast)	*P. homarus homarus*	Present study	119.4CL	0.30	0.009	pooled

(163-198 mm TL) and 44-74 mm CL (126-208 mm T) in 514 days. Radhakrishnan and Vijayakumaran (1984) reported an increase of 18 mm CL and a weight gain of 50 g in 165 days while Syda Rao *et al*. (2012) observed 96.68 g weight gain in 135 days in open sea cage culture of *P. homarus homarus*. These studies indicate a higher growth rate for *P. homarus homarus* reared in captivity, compared to growth in wild populations.

The present study indicated two annual recruitments for *P. homarus homarus* in September (18.79%) and in May (15.70%). Spawning studies on *P. homarus homarus* in captivity conducted by Vijayakumaran *et al*. (2005) showed 2-3 repeated spawnings and a maximum of seven spawnings during a year under good feeding regimes. Thangaraja (2011) reported peak breeding activity of *P. homarus homarus* in November and December when the preferred food *Perna indica* was plenty in the coastal areas at Khadiyapatanam. Thangaraja and Radhakrishnan (2012) reported that the availability of *Perna indica* during October to February coincided with the fishing season and maximum breeding activity of *P. homarus homarus* along the south-west coast of India. Virtual population analysis revealed that the maximum fishing mortality is in the size range from 46 to 80 mm CL. George (1965) observed six year classes in the fishery and is of the view that an age group which comes into the fishery at 131-140 mm TL (45-50 mm CL) could be traced during the succeeding five years, reaching about 300 mm TL (11.0 mm CL) at the end of the fifth year. The result from the present study is in agreement with the previous observation made by George (1965) pertaining to the length at capture.

The relative yield per recruit and biomass per recruit were determined as a function of L_c/L_∞ and M/K in the present study and the values were estimated as 0.28 and 2.23. Species with moderate K values have moderate natural mortality, which is related to age and size of the fish (Sparre and Venema, 1992). The K value obtained in the present study is 0.30 yr^{-1} and the corresponding M value is 0.67. Consequently, the M yr^{-1} K ratio of *P. homarus homarus* was found to be 2.23. The M/K ratio is found to be constant among the closely related species and the ratio in fishes generally falls within the limit of 1.5-2.5 (Beverton and Holt, 1959). The M/K ratio observed in Sri Lanka (Jayawickrema, 1991) for the same subspecies is 2.42 which is in close agreement with the present study.

Results of the present stock assessment study will be of use for management of this valuable species from coastal waters of south India. Radhakrishnan *et al*. (2005) reported remarkable decline in lobster resources in India and recommended management measures such as ban on operation of trammel nets, minimum legal size for export and return of berried females back to sea to conserve the lobster resource from drastic decline. Radhakrishnan and Thangaraja (2008), through a participatory management project funded by the Marine Products Export Development Authority (MPEDA), conducted village level meetings, distribution of educative posters, stickers and pamphlets, video film shows, 'V' notching and release of egg bearing lobsters involving fishermen as well as distribution of improved lobster traps to fishermen in fishing villages of Tamil Nadu. The following recommendations *viz.,* strict enforcement of minimum legal size (MLS) for fishing; ban on operation of destructive gears such as trammel nets and fishing of lobsters by divers; partial closure of the fishery during peak breeding season or ban on fishing of egg bearing lobsters; establishment of artificial habitats to provide additional substrates for young lobsters; establishment of marine reserves or lobster sanctuaries and creation of awareness among lobster fishermen on good fishing practices, were brought out under the lobster conservation project for managing the resource. In addition, investigations on recruitment in relation to environmental factors, especially on the influence of coastal current on distribution of phyllosoma larvae and puerulus settlement needs to be undertaken along the Kanyakumari coast.

Acknowledgements

Authors express their gratitude to the Director, ICAR-CMFRI, Kochi, for the facilities provided and

encouragement andthe Fisheries Resource Assessment Division of ICAR-CMFRI, Kochi for providing landing data. The authors also thank the lobster fishermen and exporters at Chinnamuttom, Kanyakumari District for giving support during sampling and data collection.

References

Al-Abdulsalaam, T. Z. 1989. *Effects of exploitation on life history characteristics of spiny lobster populations (Panulirus homarus) off Oman*. M. Sc. Thesis, Oregon State University, Corvallis, Oregon, USA, 59 pp.

Al-Marzouqi, A., Al-Nahdi, A. Jayabalan, N. and Groeneveld, J. C. 2007. An assessment of the spiny lobster *Panulirus homarus* fishery in Oman - another decline in the Western Indian Ocean? *J. Mar. Sci*., 6(2): 159-174.

Balasubramanyan, R., Satyanarayana, A. V. and Sadanandan, K. A. 1960. A preliminary account of the experimental rock lobster fishing conducted along the south-west coast of India, with bottom set gillnets. *Indian J. Fish*., 7: 405-422.

Balasubramanyan, R., Satyanarayana, A. V. and Sadanandan, K. A. 1961. A further account of the rock lobster fishing experiments with the bottom-set gillnets. *Indian J. Fish*., 8: 269-290.

Bertalanffy von, L. 1960. Principles and theory of growth. In: Wowinski, W. W. (Ed.), *Fundamental aspects of normal and malignant growth*. Elsevier, Amsterdam, p 137-259.

Beverton, R. J. H. and Holt, S. J. 1959. A review of the spans and mortality rates of fish in nature and their relation to growth and other physiological characteristics. In: Wolsteholme, G. E.W. and Connor, M. O. (Eds.), *CIBA Foundation colloquia on ageing: the life span of animals*, J & A Churchill Ltd., London, p.142-180.

Fielding, P. J. and Mann, B. Q. 1999. *The Somalia inshore lobster resource: A survey of the lobster fishery of the north-eastern region (Puntland) between Foar and Eyl,* November 1998. IUCN, Nairobi, 38 pp.

George, M. J. 1965. Observations on the biology and fishery of the spiny lobster *Panulirus homarus* (Linnaeus). *Proc*eedings of the *Symposium on Crustacea*, *Part IV*. Marine Biological Association of India, Cochin, p. 1308-1316.

Jayawickrema, S. J. C. 1991. Fishery and population dynamics of *Panulirus homarus* (Linnaeus) from Mutwal, Sri Lanka. *J. Nat. Sci. Coun. Sri Lanka* 19(1): 52-61.

Mehanna Sahar, Said Al-Shijibi, Juma Al-Jafary and Rashid Al-Senaidi 2012. Population dynamics and management of scalloped spiny lobster *Panulirus homarus* in Oman coastal waters. *J. Biol., Agric.Healthcare*, 2(10): 184-194.

Miyamoto and Shariff, A. T. 1961. Lobster fishery off the south-west coast of India: Anchor hook and trap fisheries. *Indian J. Fish*., 8: 252-268.

Mohamed, K. H. and George, M. J. 1968. Results of the tagging experiments on the Indian spiny lobster *Panulirus homarus* (Linneaus) movement and growth. *Indian J. Fish*., 15(1&2): 15-26.

Nair, R. V., Soundararajan, R. and Nandakumar, G. 1981. Observations on growth and moulting of spiny lobsters *Panulirus homarus* (Linnaeus), *P. ornatus* (Fabricius) and *P. penicillatus* (Olivier) in captivity. *Indian J. Fish*., 28: 25-35.

Pauly, D. 1980. On the interrelationships between natural mortality, growth parameters and mean environmental temperature in 175 fish stocks. *J. Cons. CIEM.*, 39 (3): 175-192.

Pauly, D. 1983. Length converted catch curves. A powerful tool for fisheries research in the tropics (Part I). *ICLARM Fishbyte*, 1(2): 9-13.

Pauly, D. 1984. Length-converted catch curves. A powerful tool for fisheries research in the tropics. (part II). *ICLARM Fishbyte*, 2 (1): 17-19.

Pauly, D. 1987. A review of the ELEFAN system for analysis of length frequency data in fish and aquatic invertebrates. *ICLARM Conf. Proc*., 13: 7-34.

Pauly, D. and David, N. 1981. ELEFAN I, a BASIC program for the objective extraction of growth parameters from length-frequency data. *Meeresforsch*., 28(4): 205-211.

Pauly, D. and Soriano, M. L. 1986. Some practical extensions to Beverton and Holt's relative yield-per-recruit model. In: Maclean, J. L., Dizon, L. B. and Hosillos, L.V. (Eds.), *Procedings of the first Asian Fisheries Forum*. Asian Fisheries Society, Manila, Philippines, p.149-495.

Radhakrishnan, E. V. 1995. Lobster fisheries of India. *The Lobster Newsletter*, 8(2): 1: 12-13.

Radhakrishnan, E. V. and Thangaraja, R. 2008. Sustainable exploitation and conservation of lobster resources in India – a participatory approach. In: Natarajan, P., Jayachandran, K. V., Kannaiyan, S., Ambat, B. and Augustine, A. (Eds.), *Glimpses of Aquatic Biodiversity - Rajiv Gandhi Chair Special Publication*. CUSAT, Kochi, p. 184-192.

Radhakrishnan, E. V. and Vijayakumaran, M. 1984. Effect of eyestalk ablation in spiny lobster *Panulirus homarus* (Linnaeus): 1. On moulting and growth. *Indian J. Fish*., 31 (1): 130-147.

Radhakrishnan, E.V., Mary K. Manisseri and Nandakumar, G. 2007. Status of research on crustacean fishery resources In: Modayil, M. J. and Pillai, N. G. K. (Eds.), *Status and perspectives in marine fisheries research in India.* CMFRI, Kochi, p.135-172.

Radhakrishnan, E. V., Deshmukh, V. D., Manisseri, M. K., Rajamani, M., Kizhakudan, J. K. and Thangaraja, R. 2005. Status of the major lobster fisheries in India. *N. Z. J Mar. Freshwat. Res*., 79: 723-732.

Sanders, M. J. and Bouhlel, M. 1984. Stock assessment of the rock lobster (*Panulirus homarus*) inhabiting the coastal waters of the People's Democratic Republic of Yemen. *FAO, RAB*/81/002/21, 67 pp.

Sparre, P. and Venema, S. C. 1992. Introduction to tropical fish stock assessment. *FAO Fisheries Technical Paper,* p. 306- 376.

Syda Rao G., Rani Mary George, Anil, M. K., Saleela, K. N., Jasmine, S., Kingsley, H. Jose and Hanumanta Rao, G. 2010. Cage culture of the spiny lobster *Panulirus homarus* (Linnaeus) at Vizhinjam, Trivandrum along the south-west coast of India. *Indian J. Fish*., 57 (1): 23-29.

Thangaraja, R. 2011. *Ecology, reproductive biology and hormonal control of reproduction in the female spiny lobster Panulirus homarus* (Linnaeus, 1758). Ph. D. Thesis. Mangalore University, India. 172 pp.

Thangaraja, R. and Radhakrishnan, E. V. 2012. Fishery and ecology of the spiny lobster *Panulirus homarus* (Linnaeus, 1758) at Khadiyapatanam in the south-west coast of India. *J. Mar. Biol. Assoc. India*, 54(2): 69-79.

Vijayakumaran, M., Senthil Murugan, T., Remany, M. C., Mary Leema, T., Dilip Kumar J., Santhanakumar, J., Venkatesan R. and Ravindran, M. 2005. Captive breeding of the spiny lobster, *Panulirus homarus*. *N. Z. J Mar. Freshwat. Res*., 39(2): 325-334.

Vijayanand, P., Murugan, A., Saravanakumar, K., Khan S. A. and Rajagopal, S. 2007. Assessment of lobster resources along Kanyakumari (south-east coast of India). *J. Fish. Aquatic Sci*., 2: 387-394.

Date of Receipt : 24.10.2013
Date of Acceptance : 06.04.2015